IX. *Obſervations of a new Variable Star. By* John Goodricke, *Eſq.; communicated by Sir* H. C. Englefield, *Bart. F. R. S. and A. S.*

Read January 27, 1785.

TO SIR H. C. ENGLEFIELD, BART.

DEAR SIR, York, Jan. 10, 1785.

THE account that has been lately given of the regular variation of Algol's light, and the notice aſtronomers have been pleaſed to take of it, are well known. It is natural therefore to ſuppoſe, that the relation of other ſimilar phænomena may alſo meet with the ſame favourable reception. Of this kind is the following, which I beg the favour of you to preſent to the Royal Society.

On the 10th of September, 1784, whilſt my attention was directed towards that part of the heavens where β Lyræ was ſituated, I was ſurpriſed to find this ſtar much leſs bright than uſual, whereupon I ſuſpected that it might be a variable ſtar: my ſuſpicions were afterwards confirmed by a ſeries of obſervations, which have been regularly continued ſince that time, and which will preſently follow in their proper place. At firſt I thought the light of this ſtar ſubject to a periodical variation of nearly *ſix days and nine hours*, though the degree of its diminution did not then appear to be conſtant; but now, upon a more cloſe examination of the obſervations themſelves, I am inclined

inclined to think, that the extent of its variation is *twelve days and nineteen hours*, during which time it undergoes the following changes.

1. It is of the third magnitude for about two days.

2. It diminiſhes in about one day and a quarter.

3. It is between the fifth and fourth magnitude for leſs than a day.

4. It increaſes in about two days.

5. It is of the third magnitude for about three days.

6. It diminiſhes in about one day.

7. It is ſomething larger than a ſtar of the fourth magnitude for little leſs than a day.

8. It increaſes in about one day and three quarters to the firſt point, and ſo completes a whole period.

Theſe eight points of the variation are perhaps inaccurately aſcertained; and indeed it cannot be expected to be otherwiſe in eſtimations of this nature, where it is very poſſible to err even ſeveral hours.

The relative brightneſs of β Lyræ, at its obſcuration in the third and ſeventh points, is nearly as follows. When in that of the third point, it is leſs than ζ and κ, and nearly equal to δ Lyræ; and when in that of the ſeventh point, it is rather leſs than ξ and θ Herculis, and much brighter than ζ, κ, and δ Lyræ. At its greateſt brightneſs in the firſt and fifth points, it is ſometimes brighter than γ Lyræ, but leſs than β Cygni, and ſometimes only nearly equal to it; but in thoſe points it ſeems to alter in its brightneſs ſeveral times in the ſame night, and that generally in a pretty conſiderable degree. However, this may perhaps be only owing to ſome fallacy of obſervation; for I have often perceived, that the relative brightneſs of ſtars is affected not only by the different ſtates of the air, but alſo by their

their change of poſition occaſioned by the earth's diurnal motion, and that particularly in ſtars of a great altitude.

The magnitudes of the ſtars, to which β Lyræ was compared during the progreſs of its variation, are as follows. β Cygni and γ Lyræ of the third magnitude; ξ and θ Herculis of between the fourth and third magnitude; ο Herculis is ſomething leſs than a ſtar of the fourth magnitude; ζ, κ, and δ Lyræ are ſtars of between the fourth and fifth magnitude, if not nearer the fifth. The relative brightneſs of theſe ſtars follows the order in which they are ſet down.

Obſervations of the brightneſs and magnitude of β Lyræ.

1784, Sept. 10. At 11 h. ±, much leſs than γ Lyræ; nearly equal to, if not rather brighter than ζ, κ, and δ Lyræ, and not ſo bright as ξ, θ, and ο Herculis; between the fourth and fifth magnitude.

Sept. 11. At 8½ h. nearly the ſame as it was laſt night, if not brighter; indifferent obſervation.

Sept. 12. At 8½ h. and 9 h. between the third and fourth magnitude; leſs than γ Lyræ, brighter than θ, ξ, and ο Herculis, and much brighter than ζ, κ, and δ Lyræ. Mr. E. PIGOTT agrees with me nearly.

Sept. 13, 15, 18, 19, and 20. It was at or near its greateſt brightneſs.

Sept. 23. At 7½ h. it was nearly equal to ζ, κ, and δ Lyræ, and much leſs than ξ, θ, and ο Herculis.

At 10½ h. the air being extremely clear, I compared it more attentively to the neighbouring ſtars, and found it as follows: rather a little brighter than δ, a little leſs than ζ, and rather leſs than κ Lyræ. Mr. E. PIGOTT thought it had rather increaſed from 8½ to 11 h.

Sept. 24. At 13½ h. certainly brighter than it was laſt night, but intervening clouds precluded all further obſervation.

Sept. 28. At 10 h. not quite ſo bright as γ Lyræ, but rather brighter than θ and ξ Herculis. Mr. E. PIGOTT thought it nearly equal to γ Lyræ.

Sept. 29. At 7½ h. not ſo bright as γ Lyræ.

At 8½ h. to 10½ h. nearly equal to ξ and θ Herculis; but if any thing it ſeemed rather leſs than ξ, and rather brighter than θ; about the fourth magnitude.

At 11¼ h. to 12¾ h. the ſame, if not leſs; I could not compare it well to ξ and θ, becauſe they were low; moon-light, but the air was clear.

Sept. 30. At 7 h. rather leſs than θ, if not equal to it; a little leſs than ξ, and brighter than ο Herculis; about the fourth magnitude.

At 11 h. and 12¾ h. it ſeemed to be on its increaſe, being for the moſt part larger than ξ and θ Herculis.

Oct. 1 and 2. About its greateſt brightneſs, but leſs than γ Lyræ. Mr. E. PIGOTT thought it brighter on the 2d than on the 1ſt, being on the 2d nearly equal to γ Lyræ.

Oct. 4. At 10½ h. I thought it rather leſs, but the weather was hazy.

Oct. 5. At 6½ h. not ſo bright as ξ and θ Herculis; a little brighter than ζ, and brighter than δ and κ Lyræ; air clear.

At 9½ h. nearly equal to ζ, and a little brighter than δ and κ Lyræ.

At 12½ h. a little leſs than ζ, nearly equal to κ, and rather a little brighter than δ Lyræ; between the fourth and fifth magnitude; air very clear.

Oct. 6. At 6¾ h. and 7¾ h. leſs than ζ and κ, and a little leſs than δ Lyræ; between the fifth and fourth magnitude.

Oct. 7. At 6¾ h. between the fourth and third magnitude; a little brighter than θ, and nearly equal to ξ Herculis; much brighter than ζ, κ, and δ Lyræ; I obſerved it till 12½ h. when it was certainly increaſed.

At 7½ h. Mr. E. Pigott thought it brighter than ξ and θ Herculis.

Oct. 8. At 8 h. nearly equal to γ Lyræ; on account of the intervening clouds, I could not perceive which was largeſt; third magnitude.

Oct. 9. At 7 h. rather leſs than γ Lyræ.

Oct. 10. At 7 h. 11¼ h. and 12 h. nearly equal to γ, if not rather leſs.

Oct. 11. At 8 h. 10 h. and 12 h. rather leſs than γ; at 12 h. if any difference, leſs than it was laſt night.

Oct. 15. At 8 h. ± nearly equal to, though rather leſs than, γ Lyræ.

Oct 16. At 6½ h. and 9½ h. little leſs than γ, if not equal to it.

At 11 h. rather larger than γ, but the weather was foggy. Mr. E. Pigott agrees with me in both obſervations.

Oct. 17. At 6½ h. and 7 h. ſomewhat leſs than γ Lyræ.

Oct. 18. At 6¾ h. between the fourth and fifth magnitude; brighter than κ and δ, and rather brighter than ζ Lyræ; good obſervation.

At 9½ h. I thought it was decreaſed, being equal to ζ and rather brighter than κ Lyræ. Mr. E. Pigott alſo thought it was decreaſing.

Oct. 19. At 6½ h. it was rather leſs than ζ and κ, and brighter than δ Lyræ.

At 8¼ h. nearly the ſame, if not increaſed.

Oct. 20. At 6½ h. rather brighter than ξ and θ Herculis, and between the fourth and third magnitude.

At 8½ h. and 11 h. I thought it was increaſed, but it was leſs than γ Lyræ; between the third and fourth magnitude.

Oct. 22. At 6 h. 8 h. and 9 h. nearly equal to γ Lyræ.

Oct. 23. At 6 h. 8 h. and 11 h. rather leſs than γ, though nearly equal to it.

Oct. 24. At 6½ h. and 11 h. leſs than γ Lyræ, and brighter than ξ and θ Herculis; at 8 h. Mr. E. PIGOTT thought it rather leſs than γ Lyræ.

Oct. 25. At 6 h. 8 h. and 11 h. nearly, though perhaps not quite equal to θ Herculis; leſs than ξ Herculis, and brighter than ζ and δ Lyræ; about the fourth magnitude. At 6½ h. Mr. E. PIGOTT thought it rather brighter than θ and ο Herculis.

Oct. 26. At 6 h. and 11 h. brighter than θ and ξ Herculis, but leſs than γ Lyræ.

Oct. 27. At 6 h. and 8½ h. brighter than it was laſt night, but ſtill leſs than γ Lyræ; much brighter than ξ and θ Herculis; the moon was at its full.

Oct. 28. At 8 h. ± rather leſs than γ Lyræ.

Oct. 29. At 9½ h. nearly equal to, though rather brighter than γ Lyræ; I ſaw them but for a ſhort time on account of clouds coming on.

Oct. 31. At 8 h. between the fifth and fourth magnitude; leſs than ζ and κ, and brighter than δ Lyræ. Mr. E. PIGOTT thought it equal to ζ Lyræ at 8¼ h.

Nov. 1. At 6½ h. between the fourth and fifth magnitude; rather brighter than ζ, and brighter than κ and δ Lyræ.

Nov. 3. At 5½ h. little leſs than γ Lyræ.

Nov. 6. At 8 h. rather leſs than γ Lyræ, and brighter than θ Herculis. Mr. E. Pigott thought it nearly equal to γ Lyræ.

Nov. 7. At 7 h. and 10½ h. much leſs than γ Lyræ; nearly equal to, if not rather brighter than, θ Herculis, and rather leſs than ξ Herculis; between the fourth and third magnitude.

Nov. 10. At 10¾ h. nearly equal to γ Lyræ. Mr. E. Pigott thought it not quite ſo bright as γ at 11 h.

Nov. 11. At 5½ h. and 7 h. a little brighter than γ Lyræ; afterwards I rather thought them equal, though β appeared for the moſt part ſomething brighter. At 11 h. and 12 h. they appeared nearly equal. At 7 h. Mr. E. Pigott thought it was leſs than γ, if there was any difference.

Nov. 12. At 6½ h. 8½ h. and 10 h. much leſs than γ Lyræ, but brighter than ξ and θ Herculis; between the fourth and third magnitude.

Nov. 13. At 6½ h. and 10 h. equal to, if not rather leſs than ζ, leſs than κ, and brighter than δ Lyræ; between the fifth and fourth magnitude. At 5½ h. Mr. E. Pigott thought it rather brighter than ζ Lyræ.

Nov. 16. At 7¼ h. little leſs than γ. At 10 h. certainly a little brighter than it.

Nov. 17. At 6 h. rather brighter than γ. At 8½ h. 9½ h. and 10½ h. brighter than γ, and leſs than β Cygni.

Nov. 18. At 9 h. 10 h. and 19 h. juſt the ſame.

Nov. 19. At 6½ h. and 8 h. leſs than γ Lyræ, and brighter than θ and ξ Herculis; between the third and fourth magnitude. At 10 h. ſomething brighter than θ Herculis.

Nov. 20. At 7 h. 8 h. and 10½ h. rather leſs than ξ, and rather brighter than θ Herculis; between the fourth and third magnitude. At 18¼ h. I thought it was increaſed; obſerved in twilight.

Nov. 21. At 7 h. ſomething brighter than θ and ξ Herculis.

Nov. 25. At 7 h. leſs than γ Lyræ, and brighter than θ Herculis; between the fourth and third magnitude. At 9¼ h. I thought it was decreaſed, being now of the fourth magnitude.

Nov. 26. At 9 h. ± much leſs than γ, and of between the fourth and fifth magnitude; but the weather was too hazy, and the moon-light too ſtrong, to obſerve well.

Nov. 29. At 7½ h. and 8 h. rather brighter than γ Lyræ. Mr. EDW. PIGOTT thought it nearly equal to γ at 8 h.

Nov. 30. At 8¼ h. and 10¼ h. brighter than γ Lyræ, and leſs than β Cygni; air clear.

Dec. 4. At 5½ h. 6½ h. and 10½ h. leſs than γ Lyræ, and brighter than θ Herculis; between the third and fourth magnitude. Mr. E. PIGOTT thought it nearly equal to γ at 6½ h.

Dec. 9. At 8 h. much leſs than γ Lyræ, and brighter than ζ Lyræ; about between the fourth and fifth magnitude. At 18½ h. it was increaſed, and nearly equal to ο Herculis; but leſs than θ and ξ; not quite of the fourth magnitude.

Dec. 11. At 6 h. and 8 h. leſs than γ Lyræ, and brighter than θ and ξ Herculis. At 8½ h. 9½ h. and 18½ h. nearly equal to, though rather leſs than γ.

Dec. 12. At 5 h. and 6 h. nearly equal to γ, though rather leſs.

Dec. 13. At 5½ h. and 9¼ h. ſomething brighter than γ.

Dec. 14. At 7 h. and 8½ h. rather brighter than γ.

Dec. 17. At 5½ h. leſs than γ Lyræ, and brighter than θ and ξ Herculis. At 7¾ h. nearly equal to γ, though rather leſs.

Dec.

Dec. 19. At 9 h. I believe it was brighter than γ, but the weather was not very favourable.

At 19 h. little leſs than γ.

Dec. 20. At 5¼ h. leſs than γ Lyræ, and brighter than θ and ξ Herculis. At 6½ h. nearly equal, though rather leſs than γ Lyræ.

Dec. 21. At 8 h. much leſs than γ, and conſiderably brighter than ζ Lyræ; not quite of the fourth magnitude.

At 18 h. a little brighter than ζ and κ, and brighter than δ Lyræ; between the fourth and fifth magnitude.

Dec. 28. At 6 h. leſs than γ and brighter than θ Herculis; between the third and fourth magnitude. At 8 h. nearly equal to θ Herculis; between the fourth and third magnitude.

1785, Jan. 5. At 5¼ h. about equal to θ Herculis; fourth magnitude.

Jan. 6. At 5¾ h. between γ Lyræ and θ Herculis, but rather nearer γ. At 8½ h. it ſeemed a little brighter than γ.

From the above ſeries of obſervations I have deduced all the concluſions relative to the eight points of the variation, as they are ſtated in the beginning of this paper. However, as at firſt it may not clearly appear, that the ſtar has a more conſiderable diminution in the third point than in the ſeventh, it will not be improper to add a few words relating to that circumſtance: for proof of it, therefore, I refer to an attentive compariſon of the obſervations of Sept. 10. Sept. 23. Oct. 5 and 6. Oct. 18 and 19. &c. correſponding to the third point of the variation with thoſe of Sept. 29 and 30. Oct. 25. Nov. 7 and 19, &c. correſponding to the ſeventh point of the variation. It may be objected, that in ſome of the obſervations of the ſeventh point, the ſtar might have become ſtill more diminiſhed in the intermediate hours; but this is not probable, becauſe in that point the ſtār has been obſerved of about the fourth māgnitude at intervals much ſhorter than in the third point, ſo that, if it had continued to diminiſh, its diminution would have proceeded at a more rapid rate, which ſtill ſhews that there is at leaſt a difference between theſe two points.

With regard to the period of the variation, it is evident from a collation of the preceding obſervations in a coarſe way, that it is nearly twelve days and three quarters. To determine it with greater accuracy is a ſubject of conſiderable difficulty, in the preſent caſe; for unleſs we can obtain very exact points of compariſon, the period would come out erroneous, eſpecially if deduced from intervals conſiſting of only a very few periods, as is the caſe here. However, as I have been able to obtain a few obſervations of the middle of its obſcuration in the third point accurate enough for our purpoſe, I have formed the following calculation.

Times of the middle of its obſcuration
in the third point.

		h.		d.	h.
1784, Oct.	6	1	only a ſingle period of	12	21
—	18	22			
Oct.	18	22	D° —	12	17
—	31	15			
Oct.	6	1	two periods, each of	12	19
—	31	15			
			Hence the period on a mean is	12	19±

In aſcertaining the above times, I attended particularly to the neareſt obſervations both preceding and following. In the manner above ſtated the period may alſo be deduced from the middle of its obſcuration in the ſeventh point; but as theſe obſervations are not ſo exact as the above, I ſhall only, as a further

further confirmation, compare two of the moſt diſtant of them, *viz.* Sept. 29. 22 h. and Nov. 20. 6 h. which interval I find contains ſix periods, each of 12 d. 20 h. ±.

I have it in my intention to purſue the ſubject further, and when I have got a ſufficient number of obſervations, it will be eaſy to determine the period with greater exactneſs, and alſo at the ſame time to aſcertain the other particulars of the variation with more preciſion. In the mean while I wiſh that this account may be conſidered as being yet imperfect; but I was induced to ſend it in its preſent ſtate, in hopes that other aſtronomers may contribute by their obſervations to the elucidation of this phænomenon.

As β Lyræ is a quadruple ſtar, N° 3. of Mr. HERSCHEL's Vth Claſs of Double Stars[*], I was deſirous to ſee if any of the ſmall ſtars near it would be affected by its different changes; but they ſeemed not to ſuffer any alteration, either when it was at its greateſt or at its leaſt brightneſs. I attended to this the more particularly becauſe the loſs of the ſtar's light was very conſiderable, and the phænomenon ſeemed to be occaſioned by a rotation on the ſtar's axis, under a ſuppoſition that there are ſeveral large dark ſpots upon its body, and that its axis is inclined to the earth's orbit.

I muſt not omit mentioning here that Mr. HERSCHEL, amongſt thoſe ſtars which he ſuppoſes to have undergone an alteration, reckons β or γ Lyræ; becauſe he obſerved that γ was much larger than β, while FLAMSTEED marks both of the ſame magnitude[†]. It may alſo be added, as ſhewing that β Lyræ varied in former times, that HEVELIUS, in his Catalogue, differs from FLAMSTEED, and marks γ of the third magnitude, and β of between the fourth and third. I have, however, ſome doubts whether the variation of this ſtar does not entirely ceaſe or become leſs viſible in certain years. Theſe doubts ariſe from ſome obſervations of CASSINI in Phil. Tranſ. N° 73. p. 2198. where I find that in obſerving the new ſtar, which then appeared near the beak of the Swan, he compared it very frequently for upwards of a month to β and γ Lyræ, yet without perceiving, or even ſuſpecting, that β was variable, though it was eaſy for him to have perceived it, if the variation had then been even leſs than it is now.

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[*] Phil. Tranſ. for 1782, p. 142.

[†] Phil. Tranſ. for 1783, p. 256.

I am, &c.

JOHN GOODRICKE.